International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Durability Testing of Fibrous (Cement Bags) Concrete for Sulphate Attack

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Abstract: ***The present work is aimed to study the effect of sulphate on compressive strength of Normal concrete of M-40 grade as well as on fibrous concrete of grade M-40. The fibrous concrete was achieved by adding 0.5% of polypropylene fibers (obtained from cement bags) by weight of dry aggregates in the concrete mix. Concrete cubes of size 150mmX150mmX150mm were casted for testing the compressive strength of the concrete mixes. The cubes were immersed in sulphate solutions after 28 days of normal curing and the reduction in compressive strength and weight was obtained for 30 and 60 days. The results show that fibrous concrete showed better performance as compared to the normal concrete when exposed to the sulphate environment.***

Keywords: durability, fibrous concrete, sulphate attack, polypropylene fibers.

1. Introduction

Concrete is a composite material made of coarse aggregate, fine aggregate and a binder material, generally hydrated cement. It is a brittle material which completely loses its loading capacity when failed. This deficiency of the concrete can be overcome by addition of discrete fibers (Song and Hwang, 2004). The concrete thus obtained is termed as fibrous concrete (FC) or fiber reinforced concrete (FRC). At present, various materials like glass, steel, nylon, polypropylene, carbon etc. have been successfully used for making fibrous concrete. The most popular among these are steel fibers, followed by nylon, polypropylene, carbon and glass (Stevens, 1995 and Banthia, 2012).

The cement industries produce tons of cement every day to fulfill the demands of construction. The cement is transported in bags from one place to another. These bags are generally made of polypropylene material. After the consumption of the cement as the construction material the bags are of no use. Thus, these bags can be used in FRC's in the form of fibers to enhance the properties of the concrete.

2. Objectives

1. To study the effect of addition of 0.5% of polypropylene fibers (cement bags) by weight of dry aggregates in concrete.
2. To study the effect of Magnesium Sulphate ($MgSO_4$) solution (5% weight by volume) on normal concrete and fibrous concrete in terms of compressive strength.
3. To study the effect of Magnesium Sulphate ($MgSO_4$) solution (5% weight by volume) on normal concrete and fibrous concrete in terms of weight.

3. Experimental Procedure

The experimental procedure included casting and curing of normal and fibrous concrete. The fibrous concrete was made by addition of fibers at the final stage after the construction of the normal concrete. The present investigation is based on the determination of reduction in weight and compressive strength in normal concrete and fibrous concrete when exposed to different sulphate environments.

Properties of ingredients used in mix proportion are:

a) Cement: OPC grade 43 with specific gravity 3.16.
b) Fine aggregate: Locally available sand of zone-I.
c) Coarse aggregate: 20mm with specific gravity 2.89, 10mm with specific gravity 2.83 and 6mm with specific gravity 2.80. The average water absorption is 0.96%.
d) Fibers: Cement bags were cut in to fibers of length varying from 3.5cms to 4.5cms.
e) Water: Portable water confirming to IS 456:2000. The water cement ratio was 0.36.

M-40 concrete mix has been used with the proportion of cement : fine aggregate : coarse aggregate as 1:1.31:3.04. Concrete cubes of size 150mmX150mmX150mm were casted for normal concrete and fibrous concrete. The concrete was filled in three layers and each layer was tamped 35 times. After 24 hours the cubes were removed from mould and kept in the curing tanks. Compressive strength of the concrete cubes was determined after 7 days and 28 days of normal curing.

After normal curing the cubes were air dried for 24 hours and their initial weight was taken. Afterwards, the cubes were immersed in curing tanks containing 5% sulphate solutions of magnesium. The cubes are kept in these tanks for 30 and 60 days after which the cubes were taken out again air dried for 24 hours and weighed for the final weight. After this the cubes were tested for their compressive strengths.

4. Results

4.1 Slump

Table 1: Slump of concrete mixes

S. No.	Slump (mm)	
	Normal	Fibrous
1	32	30
2	30	28
3	32	28
4	28	30
5	34	32
6	30	28
Avg.	31	29.33

4.2 Compressive strength of normal concrete after 7 and 28 days of normal curing

Table 2: Compressive strength of normal concrete in normal curing

S. No.	Load (KN)	Compressive Strength (N/mm^2)	No. of days
1	650	28.88	7 days
2	630	28	
3	890	39.55	28 days
4	870	38.66	

4.3 Compressive strength of fibrous concrete after 7 and 28 days of normal curing

Table 3: Compressive strength of fibrous concrete in normal curing

S. No.	Load (KN)	Compressive Strength (N/mm^2)	No. of days
1	640	28.44	7 days
2	670	29.77	
3	900	40	28 days
4	880	39.11	

4.4 Compressive strength of normal concrete after 30 and 60 days of exposure to Magnesium Sulphate solution

Table 4: Compressive strength of normal concrete after exposure to $MgSO_4$ solution

S. No.	Load (KN)		Compressive Strength (N/mm^2)		% Reduction in C.S.	No. of days
	Initial	Final	Initial	Final		
1	880	840	39.11	37.33	4.54	30
2	880	830	39.11	36.88	5.68	30
3	880	810	39.11	36	7.95	60
4	880	800	39.11	35.55	9.09	60

4.5 Compressive strength of fibrous concrete after 30 and 60 days of exposure to Magnesium sulphate

Table 5: Compressive strength of fibrous concrete after exposure to $MgSO_4$ solution

S. No.	Load (KN)		Compressive Strength (N/mm^2)		% Reduction in C.S.	No. of days
	Initial	Final	Initial	Final		
1	890	840	39.55	37.33	5.61	30
2	890	850	39.55	37.77	4.49	30
3	890	800	39.55	35.55	10.11	60
4	890	830	39.55	36.88	6.74	60

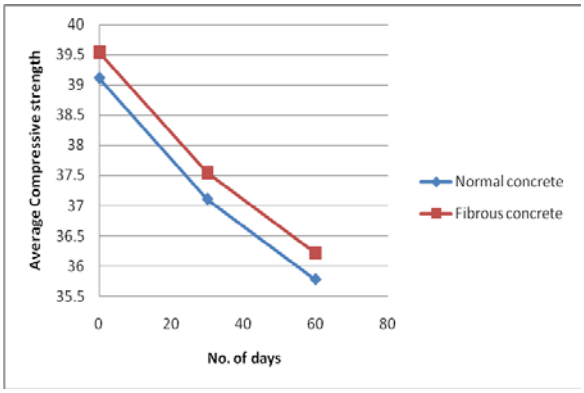

Figure 1: Comparison in strengths of concrete mixes after exposure to $MgSO_4$ solution

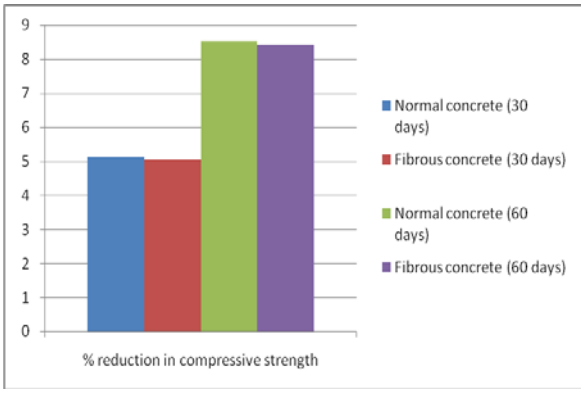

Figure 2: Comparison in % strength reductions of concrete mixes after exposure to $MgSO_4$ solution

4.6 Weight reduction in normal concrete after 30 and 60 days of exposure to Magnesium Sulphate solution

Table 6: Weight loss in normal concrete after exposure to $MgSO_4$ solution

S. No.	Weight (Grams)		Reduction in weight (grams)	% Reduction in weight	No. of days
	Initial	Final			
1	8746	8658	88	1.006	30
2	8782	8700	82	0.934	30
3	8948	8800	148	1.654	60
4	8860	8736	124	1.399	60

4.7 Weight reduction in normal concrete after 30 and 60 days of exposure to Magnesium Sulphate solution

Table 7: Weight loss in fibrous concrete after exposure to $MgSO_4$ solution

S. No.	Weight (Grams)		Reduction in weight (grams)	% Reduction in weight	No. of days
	Initial	Final			
1	8348	8275	73	0.874	30
2	8228	8165	63	0.765	30
3	8198	8081	117	1.427	60
4	8288	8162	126	1.520	60

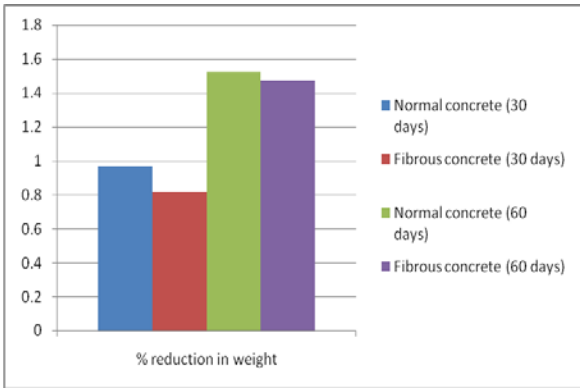

Figure 3: Comparison in % weight reductions of concrete mixes after exposure to $MgSO_4$ solution

5. Conclusions

1. Addition of polypropylene fibers (obtained from waste cement bags) in concrete resulted in increased compressive strength as compared to the normal concrete.
2. Addition of fibers resulted in decreased slump thus reducing the workability of fibrous concrete as compared to normal concrete.
3. After exposure to magnesium sulphate solution the average percentage strength reduction in compressive strength of normal concrete is found to be more than that of the fibrous concrete.
   a. The maximum percentage reduction in strength obtained for normal concrete is 5.68 % for 30 days and 9.09% for 60 days.
   b. The maximum percentage reduction in strength obtained for fibrous concrete is 5.61% for 30 days and 10.11% for 60 days.
4. After exposure to magnesium sulphate solution the average percentage weight reduction in normal concrete is found to be more than that of the fibrous concrete.
   a. The maximum percentage reduction in weight obtained for normal concrete is 1.006 % for 30 days and 1.654% for 60 days.
   b. The maximum percentage reduction in weight obtained for fibrous concrete is 0.874 % for 30 days and 1.520% for 60 days.

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Author Profile

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